(12) UK Patent Application (19) GB (11) 2 062 860 A

(21) Application No 7938343
(22) Date of filing 6 Nov 1979
(43) Application published 28 May 1981
(51) INT CL³ G01K 1/14
(52) Domestic classification G1D 52
(56) Documents cited GB 267500
(58) Field of search G1D

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(54) Temperature sensing assembly

(57) A temperature sensing assembly for attachment to a body, such as, a pipe whose temperature is to be measured, comprises a sensor 2, e.g. a resistor or thermocouple, which is enclosed in a good thermally-conductive housing 12 such that, when the assembly is attached to the body, a portion of the temperature sensor, e.g. the front face, and a part 14 of the housing are exposed to the body. Thermal insulation 10 and 16 is present around the sensor 2 and housing 12. A second thermally-conductive housing, externally insulated, can extend around the insulation 16, with a part of this second housing exposed to the body. Electrically insulating material may be interposed between the sensor and body whilst a heat conducting grease may be applied to the mating surfaces of the assembly and the body, to exclude any air pockets therebetween.

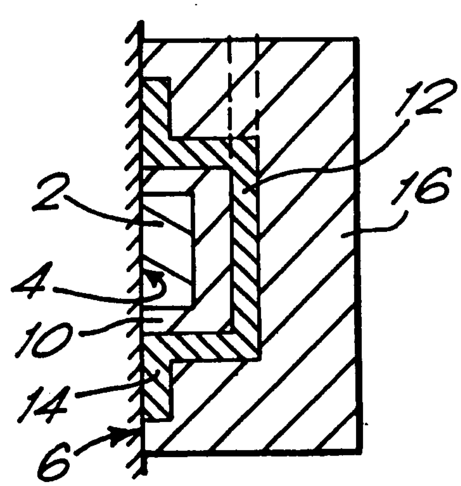


FIG.2B.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

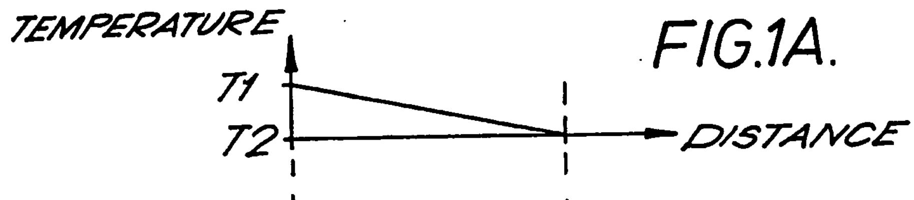


FIG.1A.

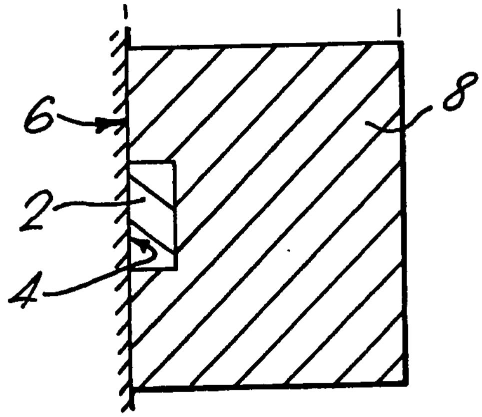


FIG.1B.

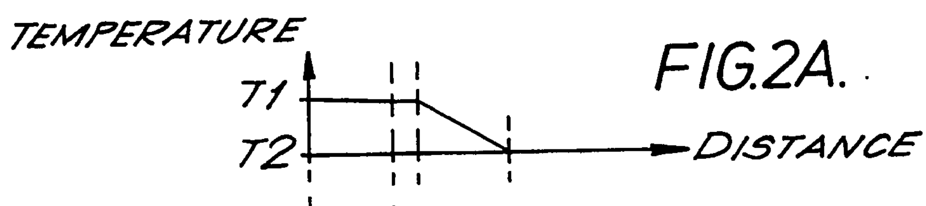


FIG.2A.

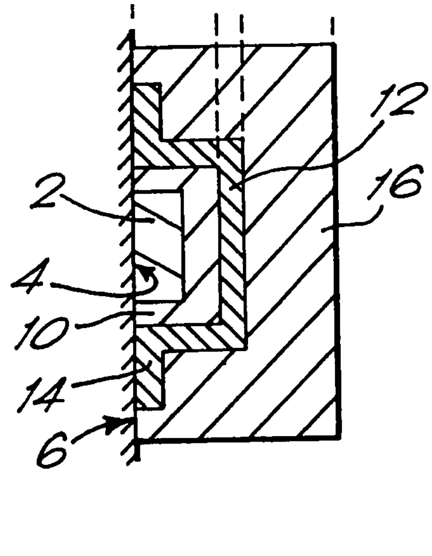


FIG.2B.

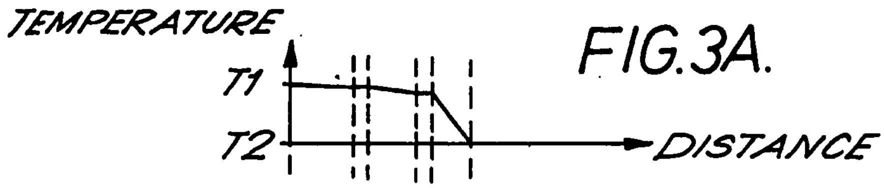


FIG.3A.

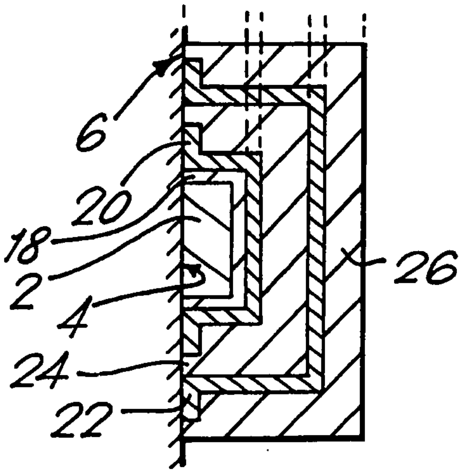
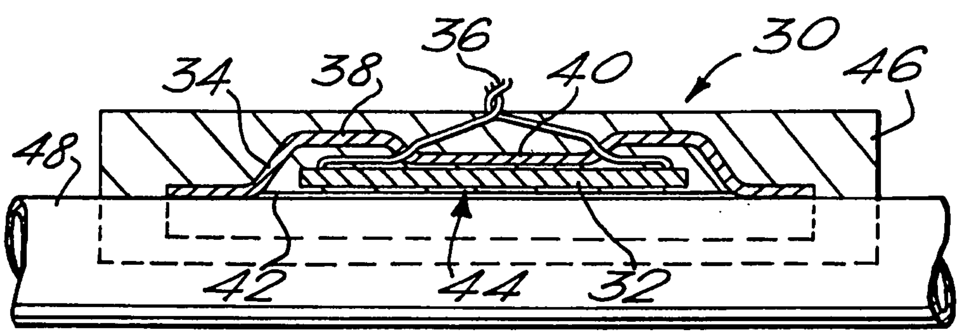


FIG.3B.

FIG.4.



SPECIFICATION

Temperatur s nsing assembly

This invention relates to a temperature sensing assembly, and its method of manufacture.

A temperature sensing assembly is used, for example, in a thermal energy meter, which may be of the type disclosed in our co-pending British Patent Application No 7842478. In the meter of that applicaiton, two temperature sensors are mounted on pipes respectively carrying hot water to and cold water from a domestic hot water system. The temperature difference measured by the two sensors is then used in deriving the amount of thermal energy delivered to the system. It is important that the sensors provide an accurate indication of the temperature of the pipes, and thus of the contents, notwithstanding the effects of different ambient temperatures and fluctuations therein.

Ideally, a temperature sensing element is immersed in, or wholly surrounded by, the material whose temperature is to be measured. However, in many instances it is necessary to measure the temperature of a body by sensors attached to its outer surface. Conventionally, such sensors are covered by a thick blanket of thermally-insulating material, to reduce the heat flow to or from the surrounding air.

It is the object of the present invention to obtain better isolation from the external temperature, at the same time reducing the thickness of covering required.

It is a feature of a temperature sensing assembly and its method of manufacture, in accordance with the present invention, that a temperature sensor of the assembly is enclosed in a housing that is a good thermal conductor in such a way that the front of the sensor and part of the housing are exposed to the body whose temperature is to be measured.

Preferably, the housing is enclosed, except at the front of the sensor, in thermally-insulating material to reduce heat loss therefrom.

A further thermally-conductive housing may extend around the enclosed insulated housing, the front of which is exposed to the body whose temperature is to be measured, thereby additionally to conduct heat from the body around the sensor to improve its temperature-measuring accuracy.

Preferably the further housing is also enclosed within a thermally-insulative material.

Preferably the or ach housing is made from metal.

The thermal sens r may be, for example, an electrical resistanc theremometer or a thermo-c uple.

The r each thermally-conductive housing may be shaped to conform t the outer surface of the body whose temperature is to b measured, so as to provide good thermal contact between the sens r and the body. This contact may also be physical contact, with a thin layer of lectrically-insulative material being interposed if necessary, and a heat conducting grease may be applied to the mating surfaces to exclude air pockets.

With an assembly according to the present invention, heat from the body whose temperature is to be measured is conducted through the or each housing to the side and back of the sensor, whereby the sensor is more completely exposed to the temperature of the body and is less exposed to the, generally different, ambient temperature and any fluctuations therein. Accordingly, a more accurate measurement is obtained of the temperature to be measured.

Temperature sensing assemblies, each in accordance with the present invention, will now be described, with reference to the accompanying schematic drawings, in which:

Figure 1A is a section through a known temperature sensing assembly;

Figure 1B is a graph showing the temperature distribution across the assembly of Fig. 1A;

Figures 2A and 3A are sections through a first and second embodiment respectively of the present assembly;

Figures 2B and 3B are graphs showing the temperature distribution across the assembly of Figs. 2A and 3A respectively;

Figure 4 is a more detailed section through a third embodiment of the present assembly, when mounted on a water pipe.

Referring to Figs. 1A and 1B, a temperature sensor 2 is mounted to have one face 4 thereof in contact with a surface 6 of a body whose temperature is to be measured. Away from the face 4, the sensor 2 is completely enclosed within a thick block 8 of thermally insulative material.

Fig. 1B shows the temperature across the insulating block 8 as a function of the perpendicular distance from the surface 6. It is seen that the temperature decreases linearly from a value T1 at the surface 6 to a value T2, being that of the ambient temperature, at the exposed outer edge of the block 8.

Referring to Fig. 2A, in the assembly in accordance with the invention, the sensor 2 is again mounted with one face 4 in good thermal contact with the surface 6 whose temperature is to be measured, and the sensor 2 is surrounded by a thin first layer 10 of thermally insulating material. A metal housing 12 xt nds beyond th layer 10 and along the surface 6, and ntirely encloses th sensor 2 and its surrounding insulating lay r 10. Th housing 12 has a flange 14 that extends around the sensor 2 along the surface 6 in go d thermal contact th rewith. A second layer 16 of thermally insulating mat rial extends compl tely around the housing 12.

It is s en that, as with the known assembly of Fig. 1A, the front face 4 of the sensor 2 is exp sed to th surface 6. Additi nally, how- v r, the flange 14 f th conductive housing 12 is also exposed to the surface 6 and operates to conduct heat from the surface 6 around the whole of the sensor 2, so as more completely to expose the sensor 2 to the temperature of the surface 6.

Fig. 1B shows the temperature distribution across the assembly of Fig. 2A, and it can be seen that the temperature at the back of the sensor 2 is only slightly less than that of the surface 6 and thus of the temperature obtaining at the front surface 4 of the sensor 2. Since there is virtually a flat temperature distribution across the body of the sensor 2, it will more accurately represent the temperature of the surface 6 than is the case with the assembly of Fig. 1A. It is also seen from Fig. 2B that it is not until beyond the housing 12 from the surface 6 that the temperature distribution has an appreciable gradient.

Referring to Fig. 3C, the sensor 2 is again mounted with its front frace 4 in good thermal contact with the surface 6. In this instance not only is the sensor mounted within a first insulating layer 18 in a conductive housing 20, but the housing 20 is itself completely contained within a second thermally conductive housing 22 and separated therefrom by a second insulating layer 24. The entire outer surface of the second housing 22 is enclosed by a third insulating layer 26.

In this second embodiment, therefore, two thermally conductive paths are provided from the surface 6 so as completely to enclose the sensor 2.

Fig. 3B indicates that there is virtually no reduction in temperature across the assembly as far away from the surface 6 as the outer edge of the first housing 20, and even then there is only a slight reduction until the outer edge of the second housing 22 is reached.

It will be appreciated that the rectangular section of the sensor 2 shown in the Figures is only schematic, and that the sensor will in practice be of any desirable shape. The enclosing housing or housings and insulating layers will then be shaped accordingly, so as completely to enclose that part of the sensor that is not exposed to the body whose temperature is to be measured.

The assembly 30 shown in Fig. 4 comprises a thermally resistive element 32 disposed within an aluminium housing 34 of wall thickness 0.2mm to 0.3mm. Two electrical conductors 36 are soldered to respective ends of the element 32 and pass utwards through apertures in respective rais d p rtions 38 of the housing 34, being electrically insulated wher necessary. The encl sur within the housing 34 is fill d with a silicon rubber c mpound and the lement 32 p sitioned for mechanical rigidity ver a flat p rtion 40 of the housing 34 between the raised portions 38. In this way, the l ment 32 is securely mounted within the housing 34 and electrically insulat d th r from. A strip of PTFE tape 42 is placed across the opening of the housing 34 so as to insulate the front face 44 of the element 32 from the body whose temperature is to be measured. The housing 34 is covered with a layer 46 of thermally insulating material.

As shown in Fig. 4, the assembly 30 is mounted on a pipe 48 of circular cross section, and through which a fluid, for example water, is arranged to pass. To this end, a flange 50 of the housing 34 extending away from and around the element 32, and the outer insulating layer 46, are shaped to conform to the outer surface of the pipe 48. The interface between the assembly 30 and the pipe 48 is smeared with a heat conducting grease so as to exclude air pockets therefrom. The assembly is secured to the pipe in any suitable manner.

It will be appreciated that a thermal sensor mounted in an assembly in accordance with the present invention is enclosed by one, or two or even more, metal or metallic housings. Thus heat from the body whose temperature is to be measured is conducted completely around the sensor, which can, therefore, more accurately represent the temperature of the body. Furthermore, since the temperature of the whole of the sensor is maintained substantially at that of the body, a thick outer block of thermally insulating material is no longer required. This is indicated by comparison in Fig. 1A, on the one hand, and in Figs. 2A and 3A, on the other hand, of the extent of the assembly in a direction perpendicular to the surface 6.

CLAIMS

1. A temperature sensing assembly for attachment to a body whose temperature is to be measured, which assembly comprises a temperature sensor enclosed in a housing of a good thermal conductor in such a way that, when the assembly is attached to the body whose temperature is to be measured, a portion of the sensor and a part of the housing are exposed to the body.

2. An assembly as claimed in claim 1, wherein the housing is enclosed, except at said portion of the temperature sensor, in thermally-insulating material to reduce heat loss therefrom.

3. An assembly as claimed in claim 2, wherein a second thermally-conductive housing ext nds around the thermally-insulating housing and has a part which is exposed to the body, whose t mperature is to be measured, when the assembly is secured thereto.

4. An assembly as claimed in claim 3, wherein the second thermally-conductive housing is enclosed, exc pt at said portion of

the temperature sensor, in a further thermally-insulating material.

5. An assembly as claimed in any preceding claim, wher in the or each th rmally-conductive housing is made of a metal.

6. An assembly as claimed in any preceding claim, wherein the temperature sensor is an electrical resistance thermometer or a thermocouple.

7. An assembly as claimed in any preceding claim, wherein the or each thermally conductive housing is shaped to conform to the outer surface of the body whose temperature is to be measured, thereby providing good thermal contact between the sensor and the body when the assembly is attached thereto.

8. An assembly as claimed in any preceding claim, wherein a layer of electrically insulating material is interposed between said portion of the temperature sensor and the body, whose temperature is to be measured, when the assembly is attached thereto.

9. An assembly as claimed in any preceding claim, including a layer of heat conducting grease which, when the assembly is attached to a body whose temperature is to be measured, lies intermediate the assembly and the body, whereby any undesirable air pockets are excluded from therebetween.

10. A temperature sensing assembly substantially as hereinbefore described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1981.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.